

REMARKS

The specification has been amended to correct minor clerical and grammatical errors and to employ more idiomatic English. Duplicative reference numerals have been eliminated. No new matter has been entered.

Claim 1 has been amended to clarify the invention, and stress that the gas feeder is formed with a plurality of like gas outlet holes equal in open area and equally spaced in the predetermined direction. Support is found, for example, in Figure 5 of the drawings.

Claim 13 has been amended to specify that the gas feeder comprises a plurality of like gas holes equal in open area and equally spaced along a virtual line.

Pursuant to 37 CFR 1.121, marked copies of the amended specification paragraphs and the amended claims accompany this Amendment.

The drawings have been amended to conform to the specification. Corrected formal drawings will be filed upon allowance of the Application.

Turning to the art rejections, independent claim 1 requires, in part:

... a gas feeder provided between said inner tube and said wafer boat, connected to said gas inlet port and defining a gas passage gradually reduced in cross section in said predetermined direction, and formed with a plurality of like gas outlet holes equal in open area and equally spaced in said predetermined direction for blowing said gas to said wafers.

As the Examiner acknowledges, the Hattori reference fails to disclose "a gas passage gradually reduced in area." Failing to find all the necessary elements in Hattori, the Examiner then looked to the Gengler reference.

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It is not seen that Gengler supplies the missing teachings to the primary reference Hattori to achieve or render obvious claim 1 or any of the claims dependent thereon. Gengler has been cited as teaching a flow device tapered from a large diameter at its open end to a smaller diameter at its other end to assist in equalizing the pressure and flow of gas along the extending length of the device. However, in Gengler tapering is accomplished by the use of a tapered open mesh. Thus, in Gengler, the mesh at the larger diameter end has a larger number of holes than the mesh at the smaller end. Since Gengler's device is tapered, the holes must vary in size and/or spacing in order to achieve the illustrated tapered shape. Anything else is physically impossible. Applicant's claimed invention, on the other hand, requires a plurality of like gas outlet holes equal in open area and equally spaced in the predetermined direction. Thus, Gengler is different, and no combination of Hattori and Gengler reasonably could be said to achieve or render obvious claim 1 or any of claims 2-12 that depend directly or indirectly thereon.

Turning to the rejection of claims 13-19 as obvious from Hattori and Gengler and further in view of Hwang et al., claim 13, as amended, requires a plurality of like gas outlet holes equal in open area and equally spaced along a virtual line. It is submitted none of the references alone, or in combination, teach a gas feeder reduced in cross section from one end portion to the other, and having a plurality of like gas outlet holes equal in open area and equally spaced along a virtual line as required by claim 13. Hattori and Gengler, as discussed above, certainly do not teach this feature. And, Hwang et al., which has been cited as teaching an air-tight vessel for an LPCVD process does not teach or suggest this feature either. Accordingly, no combination of Hattori, Gengler and Hwang et al. reasonably could be said to achieve or render obvious claim 13, or claims 14-19 which depend directly or indirectly thereon.

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Applicant's claimed invention provides a simple and low cost solution to a technical problem that has long eluded workers in a highly developed (CVD) process. Notwithstanding, the Examiner has found it necessary to search far afield to make out a case for obviousness. These references include the Gengler applied reference from the textile field, and the Allport Patent, cited as background art, but not applied, which comes from the crop irrigation field. It is submitted both references constitute non-analogous art.

The applied Gengler reference is non-analogous art as the Gengler reference is directed to a diffuser used in the textile industry for distributing conditioned air to air jet or open end spinning machines in order to reduce the moisture deficit zone created by compressed air in spinning machines and the present invention relates to the manufacture of semiconductors.

As the Examiner knows, "two criteria have evolved for determining whether prior art is analogous: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference is still reasonably pertinent to the particular problem with which the inventor is involved." *In re Clay*, 966 F.2d 656, 23 USPQ2d 1058 (Fed. Cir. 1992).

A reference may be "reasonably pertinent," even if it is in a different field of endeavor if "it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his problem." *Id.* A person having ordinary skill in the art would not have considered references dealing with textile diffusers using ambient air, which as noted at column 3, lines 50-58, contains lint and similar foreign material, in an attempt to solve problems relating to semiconductor manufacturing. Accordingly, Applicant respectfully submits that Gengler be considered as non-analogous art, and that the rejections of claims under 35 USC

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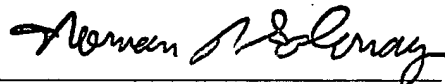
§ 103(a) based on Hattori in view of Gengler and Hattori in view of Gengler and Hwang et al. be withdrawn.

Accordingly, Applicant respectfully submits that the rejection of independent claim 13 and the dependent claims was improper and must be withdrawn.

It is believed that the Application now is in condition for allowance. Early and favorable action is respectfully requested.

In the event there are any fee deficiencies or additional fees are payable, please charge them (or credit any overpayment) to our deposit account No. 08-1391.

Respectfully submitted,



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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231 on October 28, 2002 at Manchester, New Hampshire.

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MARKED SPECIFICATION PARAGRAPHS SHOWING CHANGES MADE

Paragraph beginning at page 2, line 3, has been amended as follows:

The inner tube 3 is fixed to the base 1, and is upright on the base 1. The base 1 closes one end of the inner tube 3. The inner tube 3 is inserted into the outer tube 2 in such a manner that the centerline of the outer tube 2 is coincident with the centerline of the inner tube 3. The outer tube 2 is also fixed to the base [2] 1, and, accordingly, is upright on the base 1. Thus, the inner tube 3 and the outer tube 2 forms a double structure on the base 1.

Paragraph beginning at page 2, line 14, has been amended as follows:

The prior art reactor further comprises a boat holder 4, heaters 7a, 7b and 7c, a gas feeder 8, and exhaust gas pipe 10 and inlet gas pipes 11. The boat holder 4 is fixed to the base 1, and is provided in the inner space of the inner tube 3. The gas feeder 8 is provided in the inner space of the inner tube 3, and vertically extends from the hole toward the other end of the inner tube 3. The heaters 7a, 7b and 7c are provided around the outer tube 2, and, accordingly, the outer tube 2 is wrapped in the heaters 7a, 7b and 7c. The gas supply system is connected through the inlet gas pipes 11 to the inlet gas ports of the outer tube 2. One of the inlet gas pipes is open through the inlet gas port to the cylindrical space, and another inlet gas [pipes] pipe is open to the hole formed in the inner tube 3. Yet another inlet gas pipe is connected through the inlet gas port to the gas feeder 8, and the exhaust pipe 10 is connected to the gas outlet port of the outer tube 2. Though not shown in figure 1, a pressure regulator is connected to the exhaust pipe 10, and the pressure regulator keeps the pressure [the] in prior art reactor constant.

Paragraph beginning at page 4, line 3, has been amended as follows:

A problem is encountered in the prior art reactor in that the layers of deposited substance are different thickness. Since the gas outlet holes 9 are equal in diameter and constant in density, the pressure gradient takes place inside the gas feeder 8 as indicated by arrows AR in figure 2. The arrows AR are representative of the gas pressure [and]. When the gas outlet holes 9 are spaced from the inlet end or the open end, the arrow AR becomes shorter. The lowest arrow AR is the longest of all, and the highest arrow AR is the shortest of all. This is because of the fact that the pressure is reduced from the open end toward the closed end. The higher the gas pressure is, the larger the flow-rate is. As a result, the concentration of the reactant gas is varied with the distance from the lower end of the gas feeder 8. When a large amount of reactant gas is supplied to a semiconductor wafer, the deposition rate is increased. This results in the difference in thickness.

Paragraph beginning at page 5, line 1, has been amended as follows:

A solution is proposed in Japanese Patent Publication of Unexamined Application No. 58-197724. The prior art chemical vapor deposition system disclosed therein is equipped with a gas feeder 8a, which is corresponding to the gas feeder 8, shown in figure 3. The gaseous mixture is blown from the gas feeder 8a to semiconductor wafers supported by a wafer boat. A plurality of gas outlet holes 9a/9b are formed in the prior art gas feeder 8a as similar to the prior art gas feeder 8. However, the gas outlet holes 9a/9b are neither equal to diameter nor constant in density. The diameter is decreased from the open end toward the closed end, and the density of gas outlet holes 9a/9b are increased toward the closed end. The diameter and the density are designed in such a manner that the gas flow rate is constant over the gas feeder 8a. Since the gas concentration of the reactant gas is well controlled over the wafer boat, the deposition rate is substantially constant in the wafer boat. For this reason, any

dummy wafer is not required for the prior art chemical vapor deposition reactor, and the throughput is maintained without sacrifice of the uniformity of the deposited substance.

Paragraph beginning at page 5, line 17, has been amended as follows:

However, a problem is encountered in the prior art chemical vapor deposition reactor due to the gas outlet holes 9a/9b. In detail, the small gas outlet holes 9a are formed in the vicinity of the closed end of the gas feeder 8a at high [dense] density, and the large gas outlet holes [9a] 9b are formed in the vicinity of the open end of the gas feeder 8a. The small holes are much more liable to be clogged with the by-products, and the prior art gas feeder 8a requires cleaning frequently. If the cleaning is not frequently repeated, the semiconductor wafers are contaminated with the by-products, and the yield is lowered. Thus, the maintenance work is frequently required for removing the by-products from the prior art gas feeder 8a. On the other hand, the large gas outlet holes [9a] 9b makes the prior art gas feeder 8a breakable, because the larger gas outlet holes [9a]9b seriously reduce the surface area of the open end portion of the prior art gas feeder 8a. This means that the prior art gas feeder [9a] 8a requires an inspection and a maintenance work at short intervals. Thus, a new problem is encountered in the prior art chemical vapor deposition reactor equipped with the gas feeder 8a in the maintenance works to be carried out at short intervals.

Paragraph beginning at page 10, line 5, has been amended as follows:

The inner tube 3 has a tubular configuration, and is less in diameter than the shell of the outer tube 2. The inner tube 3 is constant in inner diameter, and is shorter than the outer tube 2. [Any] No head is [not] attached to the inner tube 3, and, accordingly, the inner tube 3 is open at both ends thereof. The inner tube 3 is provided inside the outer tube 2, and is connected to the base structure 1. The inner tube 3 is upright on the base plate of the base structure 1. A gap [takes place] exists between

the inner tube 3 and the outer tube 2, and the inlet gas port and the outlet gas port are open to the tubular space between the inner tube 3 and the outer tube 2. An opening is formed in one end portion of the inner tube 3, and is close to the circular rim of the base structure 1. The tubular space is connected to the inner space inside of the inner tube 3 through the opening.

Paragraph beginning at page 10, line 17 has been amended as follows:

The reactor further included a boat holder 4, heaters 7a, 7b and 7c and a gas feeder [8A] 8B. The boat holder 4 is provided inside the inner tube 3, and is placed on the base plate of the base structure 1. A tubular space [takes place] exists between the inner tube 3 and the wafer boat 5. The boat holder 4 is fixed to the base structure 1, and a wafer boat 5 is to be put on the boat holder 4. The semiconductor wafers 6 are supported by the wafer boat 5. The wafer boat 5 is elongated in the vertical direction on the boat holder 4, and semiconductor wafers 6 are spaced from one another in the wafer boat 5 in the vertical direction on the boat holder 4.

Paragraph beginning at page 11, line 11, has been amended as follows:

The gas feeder [8A] 8B is provided in the tubular space between the inner tube 3 and the wafer boat 5, and vertically extends along the wafer boat 5. An inner space is defined in the gas feeder 8B, and also extends along the wafer boat 5. The gas supply system is connected through the gas inlet port to the gas feeder [8A] 8B, and the gas inlet port is formed at the lower end portion of the gas feeder [8A] 8B. The upper end portion of the gas feeder [8A] 8B is closed, and gas outlet holes [9] 9C are formed at regular intervals in the intermediate portion of the gas feeder [8A] 8B. The gas outlet holes [9] 9C are vertically spaced from one another, and are directed to the wafer boat 5.

Paragraph beginning at page 11, line 20, has been amended as follows:

The inner space in the gas feeder [8A] 8B is gradually decreased in horizontal cross section from the lower end portion toward the upper end portion. Cones, frustums of [cone] cones, pyramids and frustums [are pyramid] of pyramids are typical examples of the configuration gradually decreased in the cross section. However, it is impossible to place a cone-shaped or a pyramidal gas feeder inside the inner tube 3, because most of the inner space is occupied by the wafer boat 5. For this reason, the gas feeder [8A] 8B is shaped into a part of the peripheral portion of a frustum of cone as shown in figures 6 and 7. When a circular cylinder is pressed against a frustum of conical tube, the frustum of conical tube is inwardly depressed, and the resultant configuration is similar to that of the gas feeder [8A] 8B. The cross section is like a crescent (see figure 7). A convex surface, a concave surface and a pair of semi-cylindrical surfaces, an upper surface and bottom surface form the gas feeder [8A] 8B. The gas outlet holes [9] 9C are formed in the concave surface along a virtual line, which is substantially in parallel to the vertical centerline of the wafer boat 5.

Paragraph beginning at page 12, line 12, has been amended as follows:

The gas outlet holes [9] 9C are equal in diameter, and are spaced at regular intervals. The diameter of the gas outlet holes 9C [are] is greater than that of the small gas outlet holes 9a [(see figure 3)] formed in the upper end portions of the gas feeder [8A] 8a, and is less than that of the large gas outlet holes [9a] 9b formed in the lower portion of the gas feeder [8A] 8a of prior art figure 3. For this reason, the gas outlet holes [9] 9C are easily formed in the gas feeder [8A] 8B, and are less liable to be clogged with the by-products. The inner space of the gas feeder [8A] 8B has a horizontal cross section, which is gradually decreased in area from the lower end toward the upper end. The inner space is designed in such a manner as to eliminate the pressure gradient from the gas in the inner space of the gas feeder [8A] 8B. In [order] other words, the gas pressure at all of the gas outlet holes [9] 9C is

constant regardless of the position of the gas outlet holes [9] 9C as indicated by arrows (see figure 8). Since the gas outlet holes [9] 9C are equal in diameter to one another, the amount of gas blowing out from each gas outlet hole [9] 9C is approximately equal to that blowing out from another of the gas outlet holes [9] 9C. In this instance, the doping gas is supplied from the gas supply system to the gas feeder [8A] 8B, and is blown to the semiconductor wafers 6 in the wafer boat 5 for in-situ doping. The gas feeder [8A] 8B uniformly supplies the doping gas to the semiconductor wafers 6, and the dopant is uniformly introduced into the substance deposited on all the semiconductor wafers 6.

Paragraph beginning at page 13, line 9, has been amended as follows:

Assuming now that phospho-silicate glass is to be uniformly deposited on all semiconductor wafers 6, the heaters 7a, 7b and 7c raises the temperature inside the reactor, and the pressure regulator (not shown) regulates the internal gas at a target pressure. The heaters 7a, 7b and 7c keeps the gas at the target temperature, and the pressure regulator (not shown) keeps the internal gas at the target pressure. The reactant gas TEOS, the doping gas such as PH_3 and the dilution gas N_2 are supplied from the gas supply system through the gas pipes 11 to the reactor. The reactant gas TEOS is decomposed so that silicon oxide is deposited over the semiconductor wafers 6. The doping gas PH_3 is supplied through the gas inlet port to the gas feeder [8A] 8B, and is blown to the silicon oxide grown on the semiconductor wafers 6. The phosphorous is introduced into the silicon oxide, and the phospho-silicate glass is grown on the semiconductor wafers 6. Since the doping gas concentration is constant around the semiconductor wafers 6 in the wafer boat 5, the phosphorous concentration is constant in the phospho-silicate glass deposited on all the semiconductor wafers 6.

Paragraph beginning at page 14, line 10, has been amended as follows:

The gas feeder [8] 8B may be shaped into all the peripheral portion of a cone. In this instance, the wafer boat 5 is encircled with the gas feeder [8] 8B. The gas feeder [8] 8B maybe shaped into a part of or all of the peripheral portion of a pyramid.

Paragraph beginning at page 14, line 14, has been amended as follows:

Reactant gas may be supplied to the gas feeder [8A] 8B. In this instance, the reactant gas concentration is uniform around the semiconductor wafers [5] 6 in the wafer boat 5, and the growth rate is constant on all the semiconductor wafers regardless of the position in the wafer boat 5.

Paragraph beginning at page 14, line 18, has been amended as follows:

The gas feeder [8A] 8B may be incorporated in a thermal diffusion furnace. In this instance, the dopant gas concentration is uniform around all the semiconductor wafers [5] 6, and the manufacturer achieves a target impurity profile in all the semiconductor wafers.



MARKED CLAIMS SHOWING CHANGES MADE

1. (Amended) A gas treatment apparatus comprising:

an outer tube having a gas inlet port connected to a gas supply system for receiving gas and a gas outlet port connected to an exhaust pipe, and defining an inner space;

a wafer boat provided in said inner space and holding plural wafers spaced from one another in a predetermined direction;

an inner tube provided between said wafer boat and said outer tube and elongated in said predetermined direction; and

a gas feeder provided between said inner tube and said wafer boat, connected to a said gas inlet port and defining a gas passage gradually reduced in cross section in said predetermined direction, and formed with a plurality of like gas outlet holes equal in open area and equally spaced in said predetermined direction for blowing said gas to said wafers.

13. (Amended) A gas treatment apparatus comprising:

an air-tight vessel having a gas inlet port connected to a gas supply system, a gas outlet port connected to an exhaust system and an inner space defined therein[.];

a retainer provided in said inner space and retaining plural wafers arranged at intervals[.];
and

a gas feeder connected at one end portion thereof to said gas inlet port and having a gas passage reduced in cross section from said one end portion toward another end portion of said gas feeder and [plural] a plurality of like gas outlet holes equal in open area and equally spaced along a virtual line connected to said gas passage for blowing said gas toward said plural wafers.